

# Grid Plans for High Energy Physics @ PUC

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<http://www.nwicgrid.org/>







## ➤ Assistant Prof. of Physics

### ➤ Research in High Energy Physics

- Basic Science
- Experimental Research
- Explore the constituents of matter
- Unify fundamental forces
- Search for the Higgs boson – origin of mass
- Large scale experiments

## ➤ Collaboration

- Fermi National Accelerator Laboratory – FERMILAB (TIER-1)
  - Batavia, Illinois (60 miles Northwest of Hammond)
- European Center for Nuclear Research – CERN (TIER-0)
  - Geneva, Switzerland



## ➤ Typical Design

- **Collider** – initiates collisions between sub-atomic particles
- **Detector** – detects these collisions
- **Computing farms** – record these collisions for physics analysis
- **DZERO Detector** – FERMILAB (750 physicists)
- **CMS Detector** – CERN (2800 physicists)

**Both are INTERNATIONAL Collaborations**

# PUC on the DZERO map



AZ U. of Arizona  
CA U. of California, Berkeley  
U. of California, Riverside  
Cal. State U., Fresno  
Lawrence Berkeley Nat. Lab.  
FL Florida State U.  
IL Fermilab  
U. of Illinois, Chicago  
Northern Illinois U.  
Northwestern U.  
IN Indiana U.  
U. of Notre Dame  
Purdue U. Calumet  
IA Iowa State U.  
KS U. of Kansas  
Kansas State U.  
LA Louisiana Tech U.  
MD U. of Maryland  
MA Boston U.  
Northeastern U.  
MI U. of Michigan  
Michigan State U.  
MS U. of Mississippi  
NE U. of Nebraska  
NJ Princeton U.  
NY Columbia U.  
U. of Rochester  
SUNY, Buffalo  
SUNY, Stony Brook  
Brookhaven Nat. Lab.  
OK Langston U.  
U. of Oklahoma  
Oklahoma State U.  
RI Brown U.  
TX Southern Methodist U.  
U. of Texas at Arlington  
Rice U.  
VA U. of Virginia  
WA U. of Washington



U. de Buenos Aires



Charles U., Prague  
Czech Tech. U., Prague  
Academy of Sciences, Prague



LAFEX, CBPF, Rio de Janeiro  
State U. do Rio de Janeiro  
State U. Paulista, São Paulo



LPC, Clermont-Ferrand  
ISN, IN2P3, Grenoble  
CPPM, IN2P3, Marseille  
LAL, IN2P3, Orsay  
LPNHE, IN2P3, Paris  
DAPNIA/SPP, CEA, Saclay  
IReS, Strasbourg  
IPN, IN2P3, Villeurbanne



U. of Alberta  
McGill U.  
Simon Fraser U.  
York U.



U. San Francisco de Quito



IHEP, Beijing  
U. of Science and Technology  
of China



U. of Aachen  
Bonn U.  
U. of Freiburg  
U. of Mainz  
Ludwig-Maximilians U., Munich  
U. of Wuppertal



U. de los Andes, Bogotá



Panjab U. Chandigarh  
Delhi U., Delhi  
Tata Institute, Mumbai

## The DØ Collaboration



University College, Dublin



KDL, Korea U., Seoul  
SungKyunkwan U., Suwan



CINVESTAV, Mexico City



FOM-NIKHEF, Amsterdam  
U. of Amsterdam / NIKHEF  
U. of Nijmegen / NIKHEF



JINR, Dubna  
ITEP, Moscow  
Moscow State U.  
IHEP, Protvino  
PNPI, St. Petersburg



Lund U.  
RIT, Stockholm  
Stockholm U.  
Uppsala U.



PI of the U. of Zurich

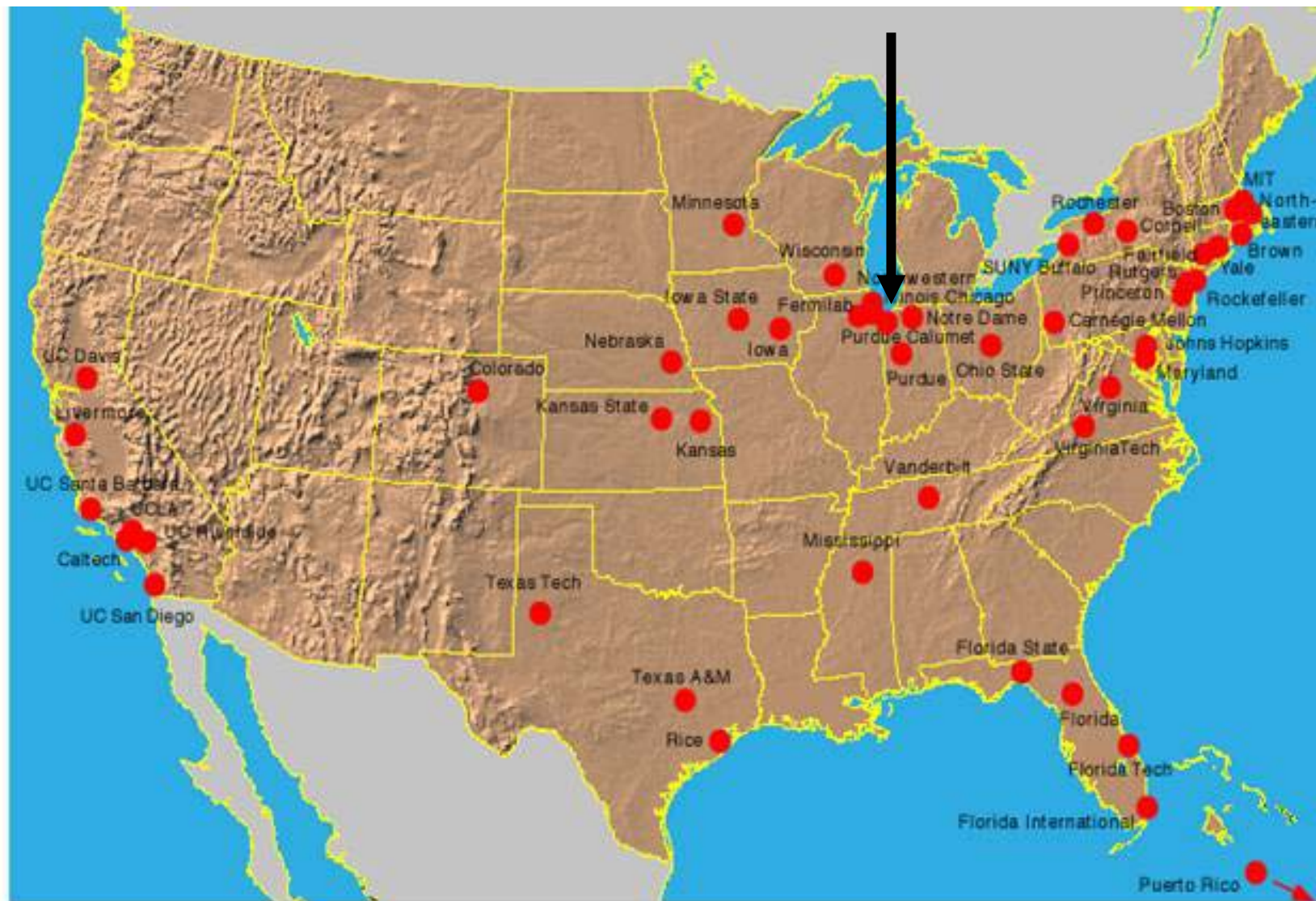


Lancaster U.  
Imperial College, London  
U. of Manchester



HCIP, Hochiminh City

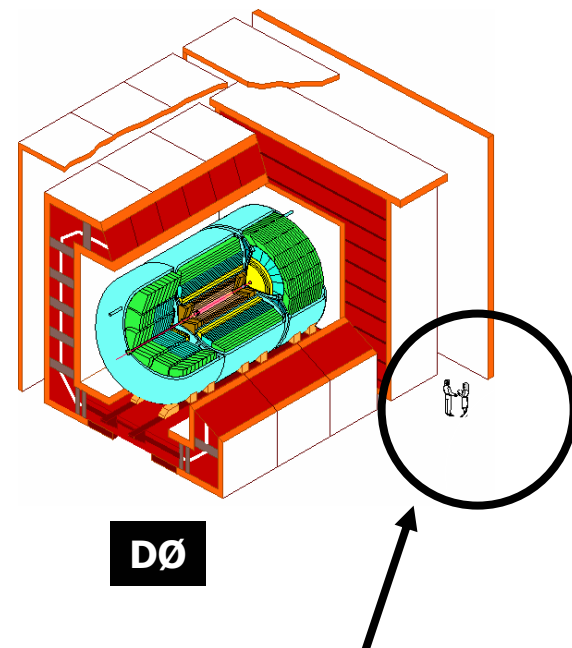
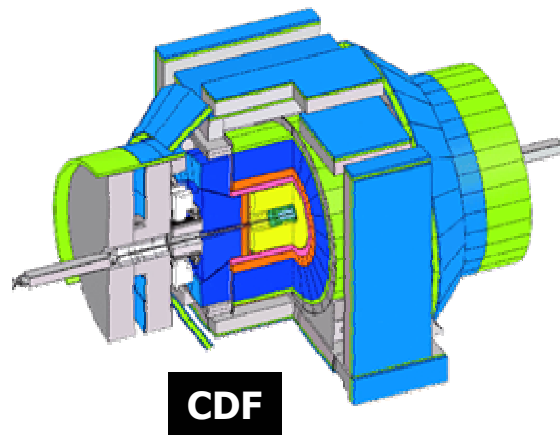
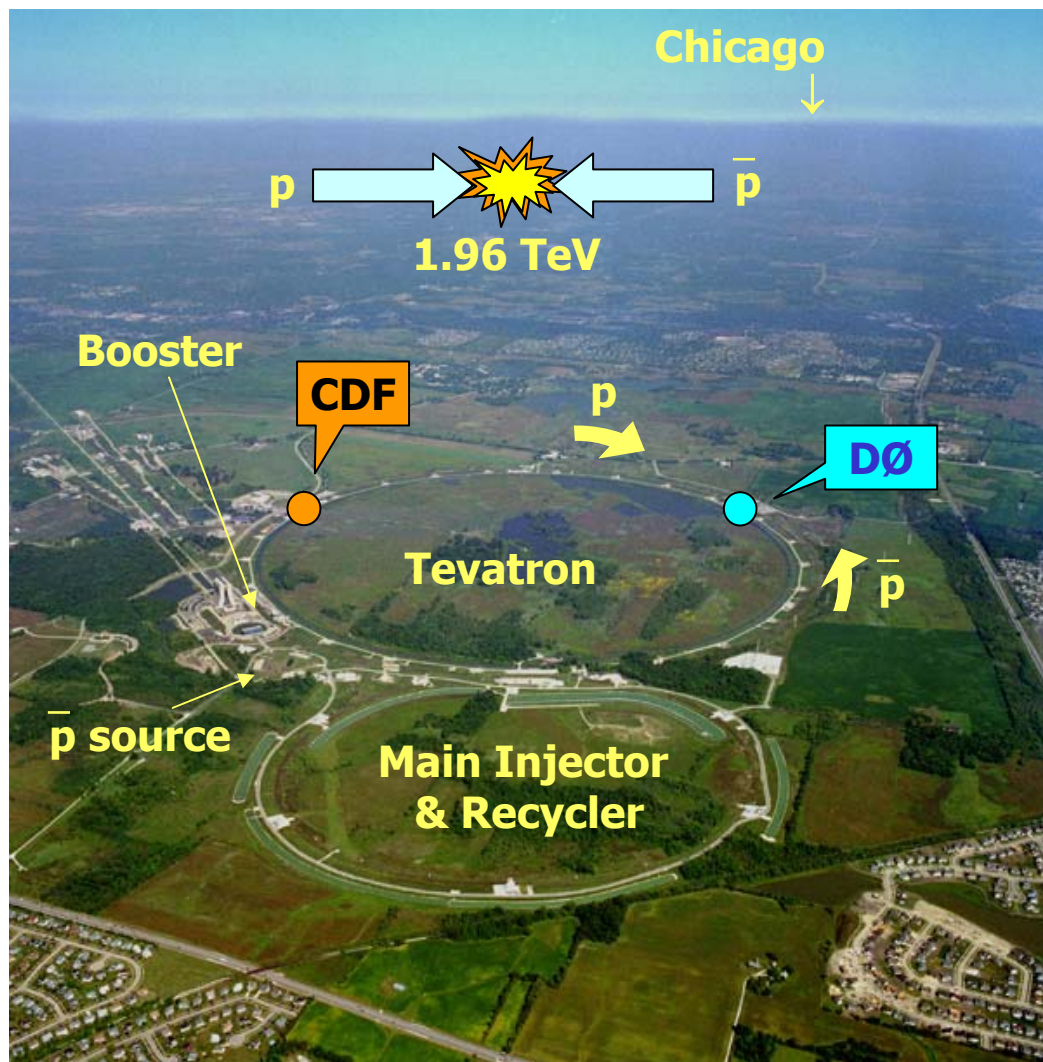
Ann Hanson, UC Riverside





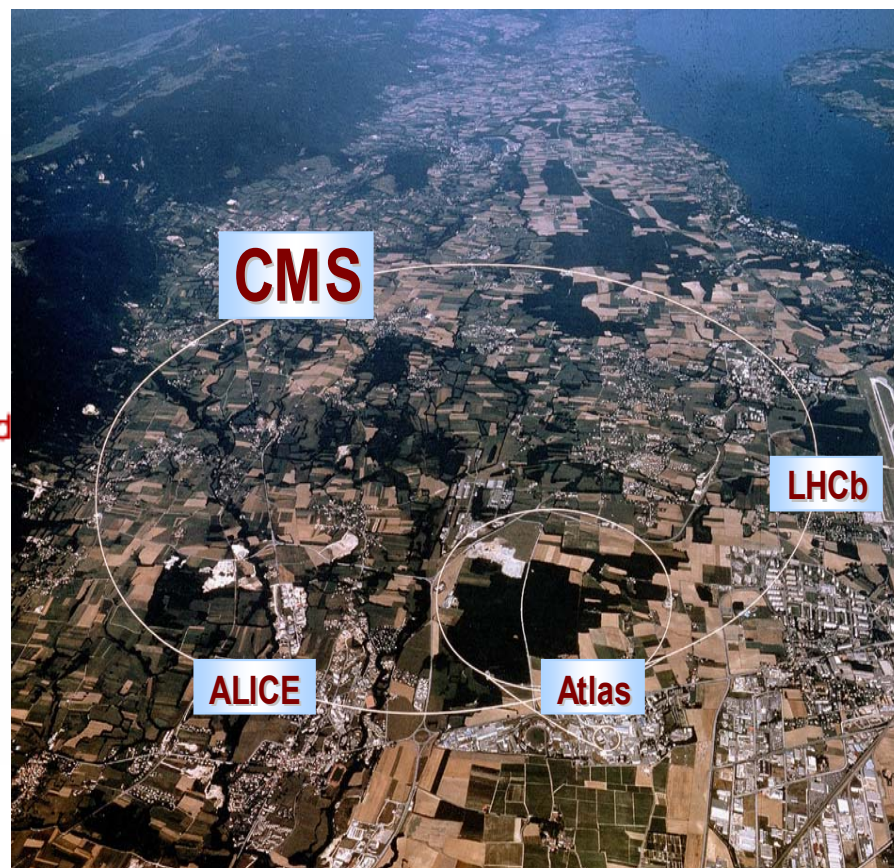
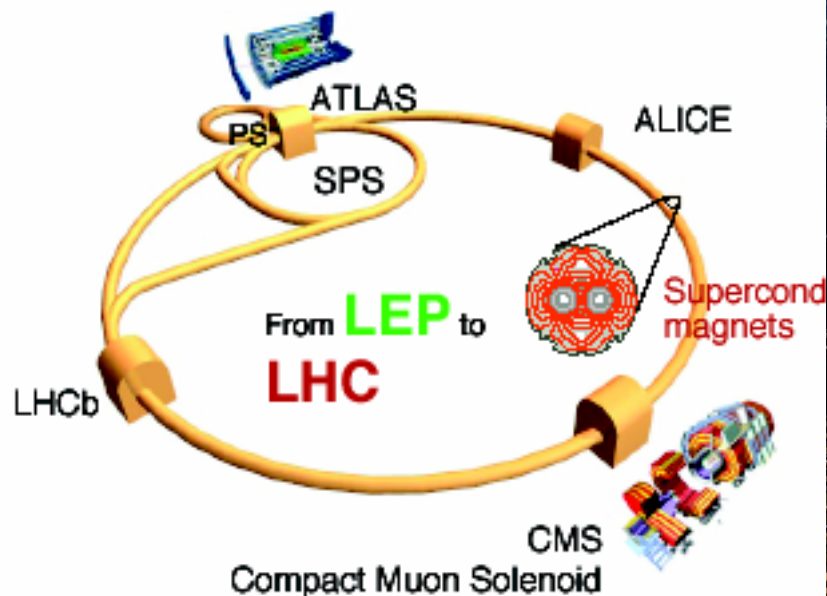
- **PUC is an official member both at Fermilab and CERN**
- **HEP Effort at PUC is led by NP**
  - Post-doctoral fellow- Dr. Vesna Cuplov
  - 1 undergraduate- Physics
  - 1graduate- Math
  - 2 Ph.D. students in collaboration with HEP group at West Lafayette – in discussion
- **CMS and DZERO research activities are funded by National Science Foundation**
- **MoU between Fermilab and PUC already signed for CMS**
  - First pot of funds arrived at PUC (FY06)
  - Second in discussion (FY07)



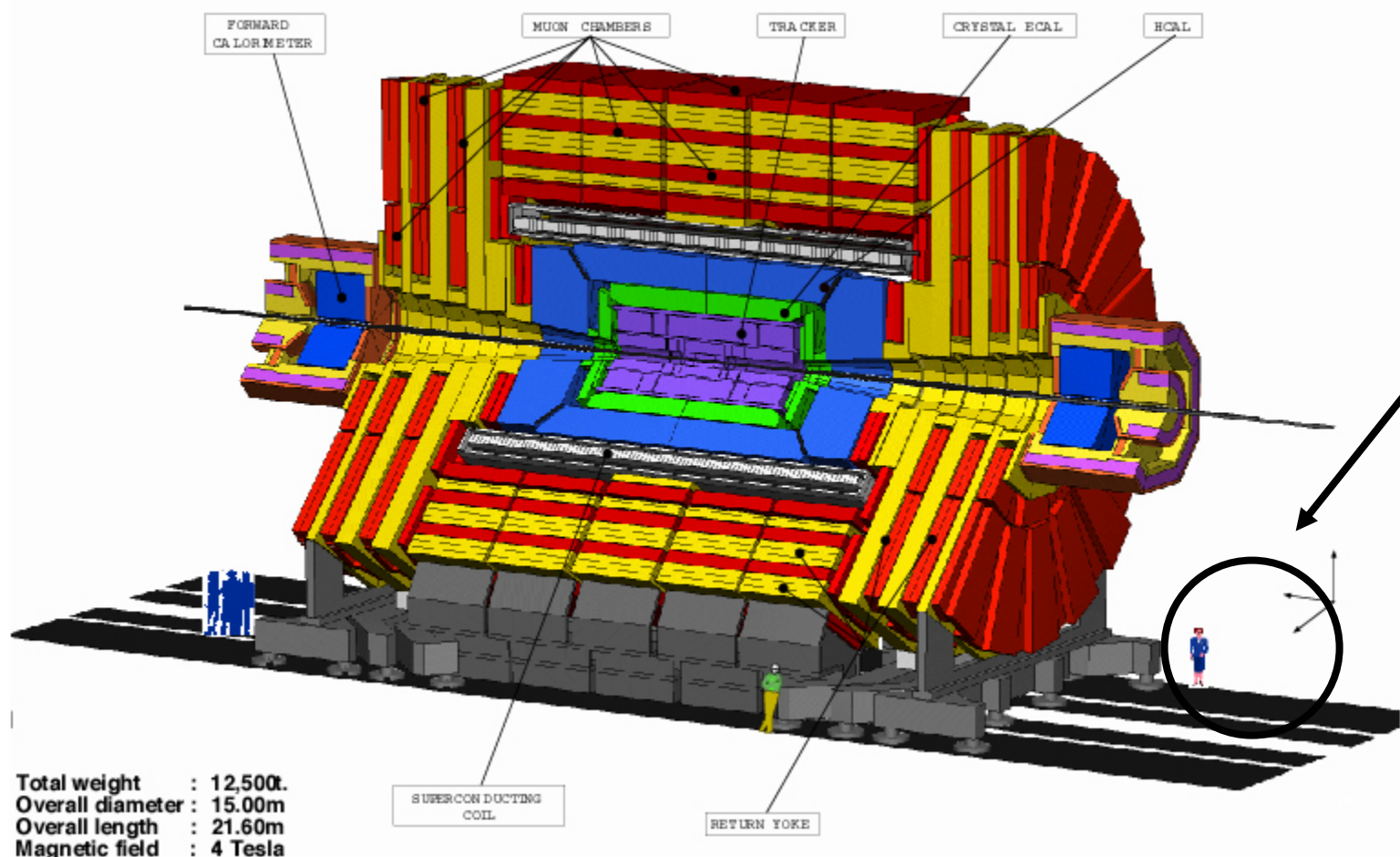




- Energy frontier, high Luminosity  $p$ - $p$ -collider at CERN, Geneva, Switzerland



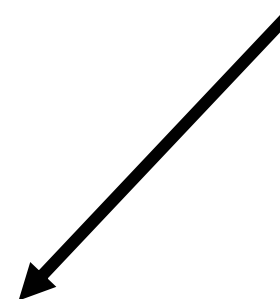
## CMS A Compact Solenoidal Detector for LHC



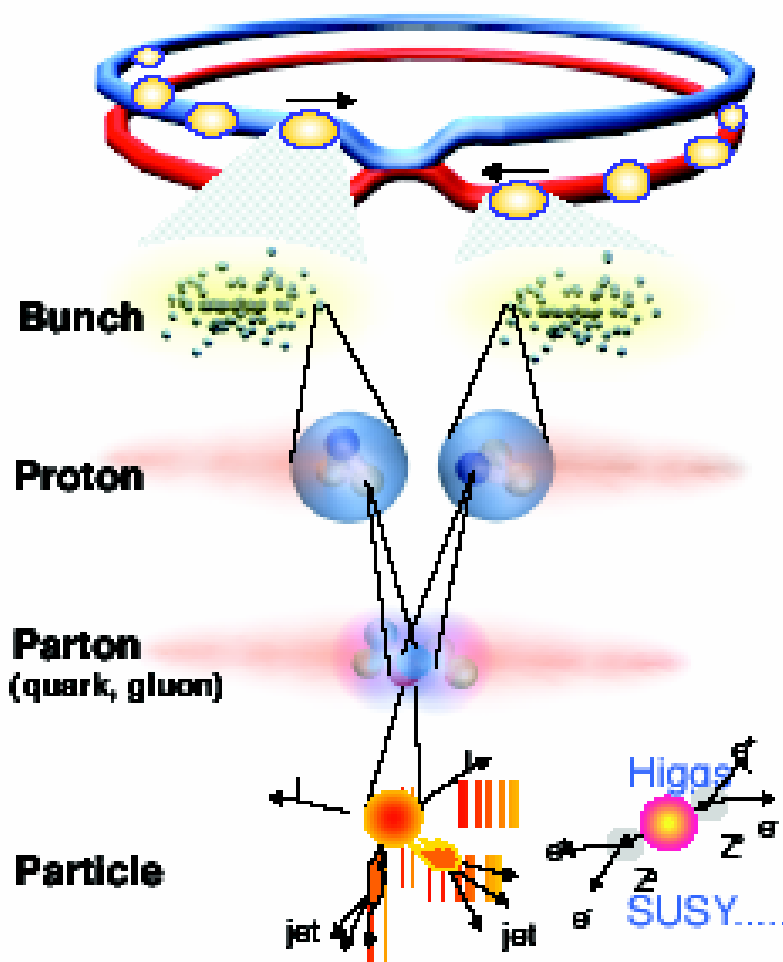




NP at Point 5, Cessy,  
CERN



# What will happen at LHC?



<b>Proton-Proton</b>	2835 bunch/beam
<b>Protons/bunch</b>	$10^{11}$
<b>Beam energy</b>	7 TeV ( $7 \times 10^2$ eV)
<b>Luminosity</b>	$10^{34} \text{ cm}^{-2} \text{ s}^{-1}$

**Crossing rate** 40 MHz

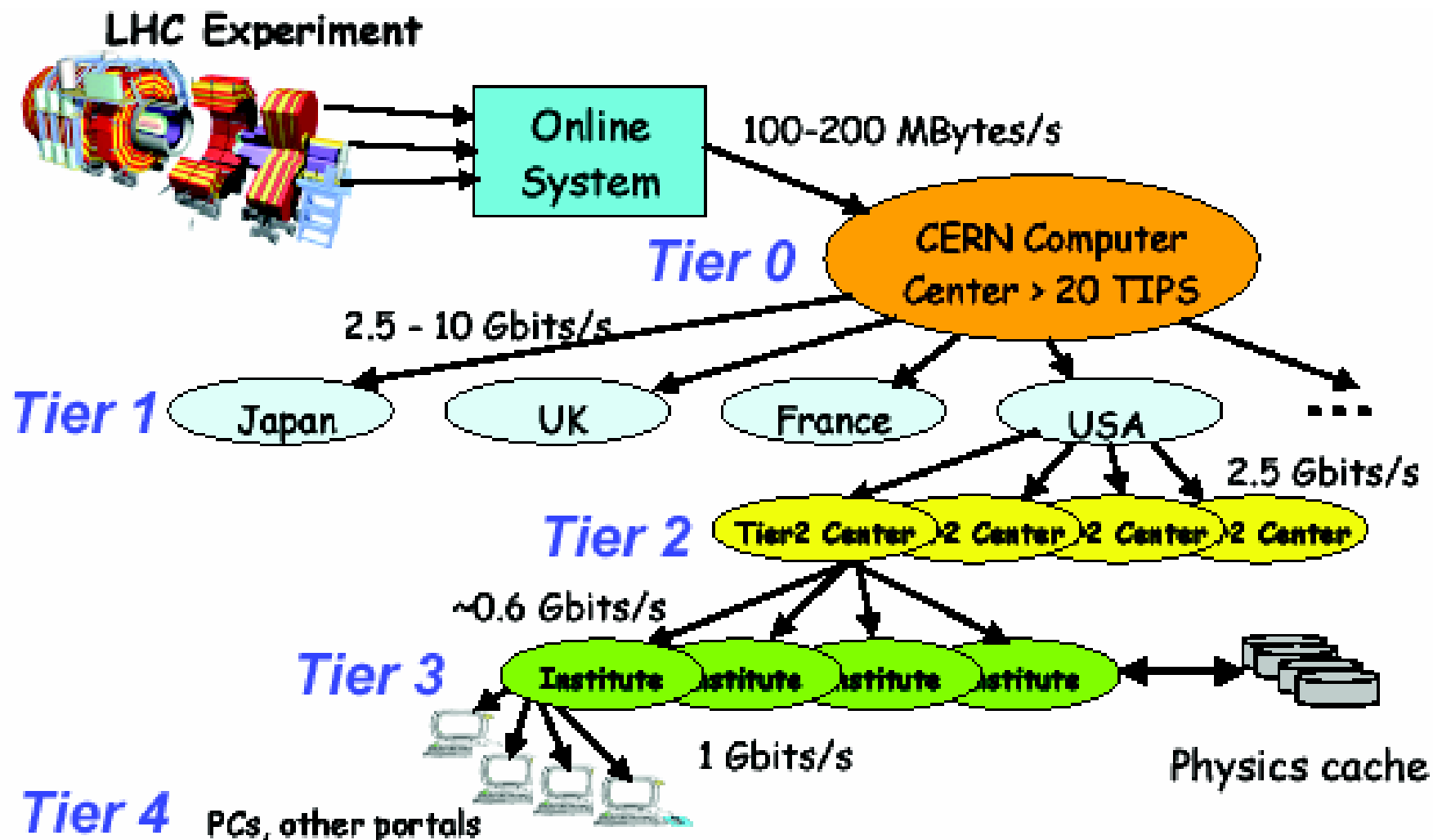
**Collision rate**  $\sim 10^9$  Hz

**New physics rate**  $\sim 0.00001$  Hz

**Event Selection:**  
1 in 10,000,000,000,000



- **Computing will be a huge challenge at the LHC**
  - Tremendous amount of data delivered (petabytes)
  - Physics is hard to find
  - Tremendous potential for discovery
- **Computing needs exceed the capabilities**
  - Scattered geographical location of collaborators
  - Bottleneck to access the same computing resources
- **Computing Grid is recognized as a solution**





- **Tier-0 (CERN)**
  - Primary reconstruction
  - Partial Reprocessing
  - First archive copy of the raw data
- **Tier-1s (Fermilab)**
  - Share of raw data for custodial storage
  - Data Reprocessing
  - Analysis Tasks
  - Data Serving to Tier-2 centers for analysis
  - Archive Simulation From Tier-2
- **Tier-2s (Purdue University, WL)**
  - Monte Carlo Production
  - Analysis



## ➤ Tier-3

- Communicate with Tier-2 for data needs
  - Maybe even provide service to Tier-2
  - Share responsibilities with Tier-2
  - Need to learn from experts
- 
- Goal is to establish PUC as Tier-3 CMS center



- **CMS has chosen a globally distributed computing model**
  - **Majority of computing resources are located away from the host lab**
- **CMS has chosen a model that drives activity at the computing tiers based on data distribution**
  - **Maintains realistic expectations on Grid services and facilities**
  - **Room for future growth of services and flexibilities**
- **The model relies on reasonable networking to succeed**
  - **Larger available networks provide for flexibility of site activities by enabling fast transitions**



- **There are successful examples in high energy physics and other sciences**
  - **Babar distributes data and analysis to Europe**
  - **D0 SAM and SAM-Grid stations**
  - **CDF Distributed CAF systems**
- **These are all successes of the last few years**
  - **Programs with lots of development**
- **A lot of time and effort is spent developing and implementing grid services**
  - **Manage data and distribute processing**
- **All of this is performed under the Open Science Grid Consortium (OSG)**



➤ **Albert Einstein**

➤ **Year 2005: Year of Physics**

## Computers

- **Incredibly fast**
- **Accurate**
- **Stupid**

## Humans

- **Incredibly slow**
- **Inaccurate**
- **Brilliant**

**Together: “Powerful beyond imagination”**